CLIMATE AND ITS RELATION TO ACUTE RESPIRATORY CONDITIONS.

By ESTES NICHOLS,

Lieut.-Col. Med. Corps, U. S. A.

FOLLOWING the last two years, during which time we have experienced a remarkable prevalence of acute respiratory diseases not previously met and studied to such an extent by this generation of observers and in reviewing many reports from all parts of the world, we frequently note reference as to the causation of epidemic bronchitis, influenza and pneumonia and their relation to certain meteorological conditions which, if not held responsible for them, are indicated as having a great influence upon the spread or the sudden termination of these diseases. As these references are made by the most serious writers, it seems necessary for us as climatologists to carefully study every meteorological condition that may have any bearing on such a formidable disease as influenza and pneumonia.

What were the unusual weather conditions, if any, prevailing to account for this most serious bacterial attack upon the human race? For instance, a medical writer in Spain states: "After the subsidence of the epidemic of influenza in Spain last spring, the summer was extremely dry, the drouth being worse than even the oldest inhabitants could remember, and the epidemic flared up again in a much severer form, and the disease, which first seemed to yield to the extreme hot weather, suddenly spread throughout the whole of Spain."

Another writer from the Philippines states that: "The disease ravaged in the islands for about six weeks, when a typhoon with torrential rain followed by strong winds swept away the last vestige of the disease."

Baccarini is inclined to believe " that the germs causing it had

their virulence suddenly enhanced by some mysterious influence, electric, atmospheric, or telluric." Another writer states: "The epidemic appeared after a very hot season had suddenly been succeeded by a very cold one and that perhaps the weather precipitated a large amount of other respiratory infections such as always become prevalent at this season (autumn)." This is answered by many other writers who state that this pandemic differs from that of 1890 and 1892 in that acute nasal catarrh and sinus involvement were conspicuous by their absence this year. It is also said that among the causes which contributed to the high incidence of influenza-pneumonia in the American Expeditionary Forces was due to soldiers working and sleeping in wet clothing and shoes, eating of food served cold, insufficient blankets for warm sleeping during the wet, cold period in northern France, yet several exhaustive reports of the incidence of influenza-pneumonia among troops stationed in barracks and tents in this country show the that weather conditions when the epidemic struck, were unsurpassed; no rain, not coudy, fair and warm—the weather being all that one could wish for the troops occupying tents, and that a long period of fine weather followed the onset of the pandemic. In letters sent out by a medical association for the prevention of disease, a slip was enclosed which reads: "Spanish influenza is undoubtedly due to lack of sunshine and fresh air, to dampness out doors and in and to getting wet feet." This is not quite as amusing as a special telegram to one of the leading Philadelphia papers dated Boston, October 7, which reads thus: "In connection with the influenza epidemic the directors of the 'Mother' Christian Science Church here announce that the mind is a source of contagion and that elements can contaminate only as diseased images held before the thought and paraded before an excited imagination preliminary to having them expressed on the body through fear and apprehension." Another writer states: "The numerous gases used on the battlefields of Europe with their highly poisonous properties, the liberation of large quantities of ground air high in carbon

dioxide content due to trench digging and shell holes, the gases from decomposing bodies of men and lower animals, and those set free by the destruction of cities and munition dumps during the last four years may have combined to form a gaseous compound with highly toxic properties probably due to rearrangement of molecules by the tremendous concussion produced by high explosives." With this idea in mind he states: "I am going to advance the theory that the condition termed influenza is in reality a non-bacterial, non-contagious disease caused by the inhalation of small amounts of depressing, highly irritating high density gas present in the atmosphere, especially at night when the air is surcharged with moisture, more particularly near the surface of the earth." He also states: "The mode of transmission is undoubtedly through the agency of the atmosphere."

The idea that some atmospheric influenza or free-from-germ explanation of infections and epidemics was promulgated by Wagner many years ago in his work on pathology under the title of "The Epidemic Constitution of Disease."

Dr. Onodera, of the Society of Internal Medicine of Japan, has laid stress on the meteorologic relation of the occurrence of influenza epidemics, the latter running parallel with the severe cold that returns at about thirty-year intervals. There may possibly be some relation of extreme cold periods and crowding.

To get an idea of what happened during the nine weeks' period from September 2 to November 9 in a meteorological study we have made a chart of the mean daily temperature for September, October and November, 1918, and also for these months for the last ten years, and have compared them with the same months for the years 1890–91. We also have made a daily chart covering the same period for precipitation, humidity, sunshine, cloudiness, wind velocity and wind direction. As a rule the epidemic began and reached its height in the eastern portion of the country in the same manner as it did in 1890.

A New England weather station was taken for observations because, like the epidemic in 1890, it commenced in New England

Monthly Mean Temperature.

	1890.	1891.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.
September	62.9	66.4	65.5	62.8	64.5	64.2	64.1	62.6	64.4	68.1	64.2	61.1	61.0
October	51.3	50.7	56.2	51.5	55.8	53.2	56.7	57.7	57.1	55.5	55.3	50.7	56.0
November	41.7	40.9	42.9	46.1	40.7	40.8	44.8	45.4	42.5	44.6	43.2	39.4	44.4

Total Monthly Precipitation.

September	5.38	3.96	0.88	3.93	1.83	2.33	2.32	2.52	0.17	1.35	2.54	2.23	6.16
October	7.63	4.62	1.58	1.76	1.15	7.44	1.22	10.64	3.81	3.30	2.05	4.68	1.20
November	0.67	2.21	0.83	1.51	4.56	6.40	3.37	2.74	3.28	1.90	2.54	1.08	3.37

Monthly Mean Sunshine.

September	52	71	62	57	60	62	50	62	80	70	73	70	59
October	42	58	60	66	68	54	63	39	55	56	72	57	55
November	65	52	48	49	53	54	57	49	57	52	63	68	53

Monthly Mean Wind Velocity.

September	5.5	6.3	7.3	8.9	7.6	8.9	7.5	8.0	8.1	8.4	9.1	7.8	8.7
October	6.8	8.7	8.7	8.6	9.8	9.0	8.1	8.8	7.9	8.8	9.5	10.4	8.2
November	7.2	9.7	8.8	10.5	9.9	10.0	9.7	8.8	10.5	9.6	8.8	9.3	8.9

Monthly Mean Prevailing Wind Direction.

September	NW	SW	N	N	N	N	N	N	N	NW	S	N	N
October	NE	N	N	W	NW	N	N	N	S	S	N	N	S
November	NW	N	N	W	NW	W	SW	N	N	SW	SW	NW	NE

Monthly Mean Cloudiness.

September	4.8	2.9	4.0	4.9	4.7	4.6	6.0	5.3	3.3	4.2	3.7	4.7	5.1
October	5.8	4.2	4.3	4.0	4.1	5.3	4.7	6.7	5.2	5.1	3.8	5.2	5.1
November	3.5	4.8	5.3	5.7	5.4	5.4	5.2	5.8	4.8	5.2	4.3	3.8	5.1

Monthly Mean Humidity.

September	85.3	61.6	73.0	76.8	77.2	74.8	77.6	76.0	65.8	77.6	73.4	70.0	75.6
October	80.4	77.7	73.0	76.8	68.2	75.0	71.4	77.8	72.0	83.4	75.4	74.4	76.6
November	76.0	74.0	71.8	68.3	71.0	67.8	68.4	68.3	65.0	68.1	76.4	61.0	70.2

and spread westward in a fan-shaped manner. As will be noted by the chart, the precipitation for the first 18 days of September was nearly 5 inches. This is a very unusual rainfall. In September of 1890 it is noted that the precipitation was also over 5 inches. The only bearing it has on acute respiratory conditions is the tendency to drive people inside and to cause crowding. So far as the other meteorologic observations are concerned, there is nothing unusual as in comparison with the period of the last ten years.

The time it took to exhaust the susceptible material was not more than eight weeks in any one place. The death rate was highest in manufacturing and lowest in strictly rural communities. All towns untouched by railroads showed a very low death rate. Conditions of housing and crowding which increased indoor contact, no matter where found, increased the death rate. The comparison of these rates with the proportion of foreign- and native-born shows that in the communities having the highest and lowest percentage of native born, the death rate rises or falls accordingly, as a high percentage of American-born means less crowding and better sanitary conditions generally.

The study of the Student Army Training Corps and students wherever located, shows that as living conditions approach those in the Army, so does the death rate approach that of the Army, I.E., when a large number of persons live, sleep and eat together in a large barrack room, the death rate is almost invariably higher. This is true no matter where people are housed in this manner, whether in army camps, miners in South Africa or the congested sections of our cities with their apartments, flats and tenements. It is noteworthy that in many of our large western and southern cantonments the morbidity and mortality was as high or higher than in many of our eastern camps, so that climatic influence does not explain the difference nor does it explain the difference in morbidity of influenza in cantonments of 15.9 per cent. being complicated with pneumonia in barrack camps

against 9 per cent. in tent camps where the men were quartered in small groups of five or six men to a tent against 50 to 150 in a barrack building.

This has also proven quite true of institutions and industrial plants where the same sort of housing has occurred. Already we have been impressed with the heavy sacrifice in human lives demanded for the privilege and necessity of assembling large numbers of men in barracks for military, industrial and educational purposes. So great has been the advance of military medicine and sanitation that one military authority has said that, "Military medicine consists only of three chapters, as follows: Chapter I, The Sputum-borne diseases; Chapter II, The Venereal Diseases; Chapter III, The Insect-borne Diseases. The chapter that most interests us is the first, the sputum-borne diseases, because it is the most important from the standpoint of climatology. They are tuberculosis, pneumonia, influenza, tonsillitis, bronchitis, measles, mumps, scarlet fever, whooping cough, diphtheria and cerebro-spinal meningitis, and the sequelae of these diseases." It seems well established that this group of infections is not ordinarily air-borne. Nevertheless, it is quite certain that they are transmitted through the medium of respiratory exhalations containing droplets of mucous enveloping disease germs. But this has no relation to any atmospheric conditions as such, unless the natural atmospheric conditions are influenced by housing or in some other manner by the hand of man.

In the barracks cantonments epidemic bronchitis was the earliest respiratory disease to be met. This disease prevailed in all camps. At the Oglethorpe group of camps over 80 per cent. of all troops had it and although some may regard bronchitis with considerable indifference, yet I believe it is a medical entity of great significance. Laboratory findings do not agree on any single organism for its cause. It is a poly-bacterial disease. Streptococci, staphylococci, influenza and other organisms were found, yet the clinical picture was very much the same in all. During the winter months of 1917 almost everybody who went

into barracks developed the disease within a week. This was especially true of the Medical Officers' Training Camp, and after seeing many cases and demonstrating it to several classes, I dubbed it "barracks bronchitis." The explosive cough, the tightness of breath, the sub-sternal pain with temperature from 100° to 103° were always noted. Auscultatory signs were the only physical signs present at first. The chest was dry, but the congestion extensive as shown by the radiograph in many instances. This general bronchial congestion went through a stage or resolution and the dry stage was followed by a shower of fine mucous râles occurring with inspiration and expiration and in turn by mixed indeterminate râles accompanied by profuse muco-purulent expectoration which frequently lasted for many weeks. Resolution was usually complete although there were not infrequently cases in which resolution was not accomplished and in which localized area more frequently at the base, but occasionally in the upper portion of one or both lungs, would show fine inspiratory râles accompanied by an irregular slight P.M. temperature. These latter cases were very confusing, especially if you first saw this end stage of localized unresolution. The cases were sent to the examining boards with a diagnosis of acute tuberculosis. These localized râles in the apex sometimes persisted for a long time as well as expectoration, which was negative for tubercle bacilli.

But with the poly-bacterial laboratory report received, the part that bronchitis played in the spread of other sputum borne diseases is worthy of consideration. This was especially noted in cases of bronchitis which developed measles. In this instance it almost equalled broncho-pneumonia and it is sad to state that nearly sixty per cent. of these cases meant death. It is also believed to have played an important part in the spread of the other sputum borne diseases.

What relation was there between bronchitis and climate? The weather may have encouraged it, while there was a good deal of cloudiness and perhaps unusually cold weather in the

fall and winter of 1917, yet there was no unusual humidity or precipitation—only the snow fall was greater.

I think we must admit, however, that climate, so far as seasons go, does play a great part in the incidence of acute respiratory diseases, especially pneumonia. We must look farther than climate, however, for the explanation of these diseases during the winter of 1917. I have always believed that no climate can rise above the conditions of housing. The quartering of troops in unaccustomed climates will not explain it, but the housing of a large number of men together in one room with the change from over-heated home to the more or less cold barracks system of many of our camps, will account for much of it, but this condition was not confined to our army camps. Acute respiratory conditions were on the rampage during the winter of 1917 among the civilian population, and I believe the foundation for the pandemic of the autumn of 1918 was then laid.

The following statement may surprise you all, but I believe that the fuel administrators had the most to do with the causes which led up to the titanic struggle between bacterial and human life. Not that they were to blame. It was a military necessity. And, my friends, it is impossible for us to play at this war game without paying for it in both the front line and the extreme rear line, or the homes that were necessarily mobilized for war purposes.

During the winter of 1917, on account of fuel shortage many people were obliged to close a large part of their houses and to live in a few rooms. This was especially true of the poor. Apartment houses were crowded and poorly heated. The people who could afford it flocked to hotels, many of which were underheated and over-crowded. People crowded together as never before witnessed in the civil population of all countries. Windows and doors had to be kept closed to keep the cold out, which resulted in a concentration of bacteria-laden, indoor air, due to coughing and sneezing. The acute respiratory conditions in 1917, I feel, had some very definite relation to those in 1918.

As the warm weather approached in the summer of 1918, these conditions subsided because windows were opened and people had reopened their closed rooms; the concentration of germ-laden air had become diluted and it almost appears that a certain concentration is necessary for the spread of some of these diseases.

As we have seen by various laboratory reports the complications of influenza were poly-bacterial, depending upon the section of country reporting—here streptococci pandemicus, there pneumoniæ pandemicus, and in some places staphylococci. In most instances the bacillus of Pfeiffer was ever-present, preparing the soil in the bronchial mucosa which had already been partly prepared by the bronchial conditions of the previous winter months. During the summer of 1918 these conditions continued to some extent, but they were notable for their mildness. What, then, accounts for the sudden virulency and onslaught of the bacteria in the fall of 1918? Bacteriologists are all familiar with the increase in virulence of strains of pneumococci passed rapidly through a succession of susceptible animals like the rabbit. Is it not reasonable to suppose that this is what happened during the summer of 1918 and with the advent of cold weather and with the unusual period of rainfall coupled with a still greater preparation to live in as few rooms as possible due to the shortage of fuel, and which actually had driven the poor to a smaller number of rooms and consequently back to a concentrated bacterial indoor atmosphere accounts for the sudden onset of the disease. And the bacterial content of this atmosphere had now attained a virulence which did not exist in 1917 and which was now able to overcome and destroy the white corpuscles and subsequently the individual. Every case we observed had a leucopenia with the exception of one, and in this case there was some very unusual condition not determined by the clinicians.

I have failed thus far to show any meteorological factor that influenced the pandemic with the exception of change in seasons. Does climate have any effect on the bacterial flora in any sense

as it does on our terrestial flora? This is a question that will bear some investigation. We are shown in studies of the epidemic that in some localities streptococci are responsible and in others that pneumococci are responsible for the broncho-pulmonary and pleuritic complications. By comparing the average of death rates from influenza it was found that there is a distinct relation between the two—that is, a community having a large death rate from pneumonia had a high death rate from influenza last winter and those having a low death rate from pneumonia had a low death rate from influenza. This relations is shown undeniably in the recent pandemic by comparing 45 large cities with the average pneumonia rate for the last sixteen years.

It may be asked why the entire population was not afflicted, which may be answered that immunity following previous epidemics may account for only 40 per cent. of the population being attacked in 1918. In the epidemic of 1890 about 40 per cent. of those exposed took the disease. All ages were attacked, but mostly those between the ages of 15 and 50 suffered. Statistical data concerning previous epidemics are so meager and imperfect, but in 1823 about 40 per cent. of the population of Paris was afflicted. In 1872 about 70 per cent. of the population of London and some of the German cities were said to have suffered. But the records of earlier epidemics are so obscure that they are of little or no value going back even to the first one imperfectly recorded in 1173.

It has been shown that more than 100,000 persons between the ages of 25 and 45 succumbed to this respiratory condition in the civilian population in 1918. A widespread epidemic caused by a specially virulent virus is usually followed by a general immunity of that portion of the population infected. Local outbreaks or sporadic cases may occur and probably will for the next few years, but the general immunity will protect against any general epidemic. Following a period of years a new susceptible population will replace the immune one and with the introduction of fresh varulent virus another general epidemic

may be looked for. This, I think accounts for the great susceptibility of young persons under 45 in this epidemic. It is 28 years since the last epidemic and as few were attacked in 1890 under 15 years of age, one would not expect many persons over 45 to have developed the disease this year.

I feel that climate will have little to do with the next outbreak, but it will come, perhaps not in my time and perhaps not for a longer period of time, but you climatologists who are present when a new susceptible population is established need not study meteorological influences or protections against it only so far as it concerns seasons. I do earnestly urge you to study housing, ventilation and sanitation and to be ever on the watch for business depressions, social problems, such as widespread strikes and new wars, which for economic reasons will cause people to live under restricted and crowded conditions.

DISCUSSION.

DR. POTTENGER: This paper of Dr. Nichols' is one of great interest to the members of the Climatological Association. There are just a few points that I would like to make. In the first place, referring to the question of contact and influenzal infection I would like to cite a few instances which point to the fact that people may become carriers of influenza. It has been reported to me, but I can not vouch for the truth of it, that sheep herders out in the mountains many miles away from civilization developed influenza. Another instance was given me by my colleague, Dr. Granville MacGowan, of Los Angeles, who had charge of a vessel sailing to the Orient during the influenza epidemic of 1889–93. He reports that they left San Francisco with a large number of passengers, all of whom had a clean bill of health. When they arrived at Honolulu everybody was still free from disease. There was no contact from the shore, the proper officers coming out in a small boat and executing whatever papers were necessary without contact. A few days later, however, influenza broke out among the passengers and a very large per cent. of those on board became infected. These two instances support the point that influenza is carried in an inactive form ready to break out under favorable conditions.

Dr. Nichols' paper is also very interesting because of its discussion of the relation between disease and climatic conditions. In this connection I would like to call attention to the work of Professor Elsworth Huntington. He has shown the influence of many

different factors such as heat, cold, humidity and dryness upon the human efficiency, morbidity and mortality. He has shown, contrary to what most of us believe, that the most favorable climate, as far as health is concerned is one in which the air is moderately moist, and with a temperature which is neither too high nor too low. This must not be interpreted, however, as being best for those who are ill. For these, the climate must suit the disease and the patient. He has shown that a moderate drop in temperature is usually favorable, but that if the cold continues, it is unfavorable and increases the number of deaths. He also shows that a rise of temperature is unfavorable and that it interferes with the well being of the individual.

Studies of this kind belong distinctly to this Association and are helpful in adding valuable facts to our medical knowledge.

DR. CHARLES W. CRANKSHAW: In the city of Newark, which is a great industrial center, we have a population of about 435,000 people and we had some 30,000 cases of influenza. I was requested to serve on the mayor's committee with the health officer and others, and at our suggestion the saloons, soda fountains, churches, schools, theatres, moving picture houses, pool rooms and every place where the public could congregate were closed and for the time being public gatherings were prohibited. All public conveyances were required to keep one or more windows open, and taking the matter from every angle, we had very good coöperation. The number of cases as compared to the population shows that evidently our getting on the job early had something to do with limiting the number of cases. At the Home Office of the Prudential Insurance Company, where there are about 4,500 employed, I wrote a letter to the Home Office employees on September 20, 1918, a copy of which was placed on more than fifty bulletin boards throughout our group of buildings, calling their attention to influenza and gave a few rules to observe. During the epidemic our disability list was never over 12 per cent. or less than 8 per cent. for all causes. We did our best to allay fear; no one was greatly alarmed and by giving them early advice and how to take proper care, I believe that we helped to some extent in checking the spread of the disease.

DR. W. F. R. PHILLIPS: I think the Association is indebted to Dr. Nichols for giving it a *climatological* paper. Since the Association added to its name and enlarged its scope, it has had few papers dealing with the important relations that obtain with respect to man and his physical environment. I am not surprised that Dr. Nichols finds no consistent relations between the recent influenza epidemic and the climatic conditions. I recall endeavoring to connect the conditions that prevailed during the epidemic of 1898–99, and with the same general result. I think, however, it is rather weather and influenza

than climate and influenza. It is necessary to distinguish between the two terms: climatic effect is a long-time effect, one that it takes decades of years to evidence; weather is a short-time effect, measured in hours or at most in weeks. That we fail to find evidence of climatic effect may be not that there is no climatic influence on influenza, but because we are without the necessary data. It should be remembered that our climatic statistics extend back not very many years, that is, taking the world at large, not more than forty years. Statistical climatology does not even now extend to that region of the world from whence influenza apparently periodically starts on its epidemic progress. When the next pandemic occurs there may be enough data to throw a ray of light on the climatic relations.

It seems regrettable that we are without climatological laboratories for the study of our problems. A number of years ago in my address as president of the Association, I called attention to the need of such laboratories if we were to make any real scientific progress in medical climatology. A few years later I showed in a paper on artificial or house climates read before this Association how in one important manner climate affected our well being. To illustrate, I cited the effect experienced by an individual on going from indoors to outdoors on an average November day in Boston, that it was equivalent climatically to going from Yuma, Arizona, to Boston in the same length of time. There can be no doubt that climate has its effect on us, the whole theory of evolution postulates this effect. We seem, however, satisfied with the postulate and content to let the quantitative and qualitative effect take care of themselves.